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A DESCRIPTION OF THE IMMATURE STAGES OF *PADUNIELLA NEARCTICA* (TRICHOPTERA: PSYCHOMYIIDAE) WITH NOTES ON ITS BIOLOGY

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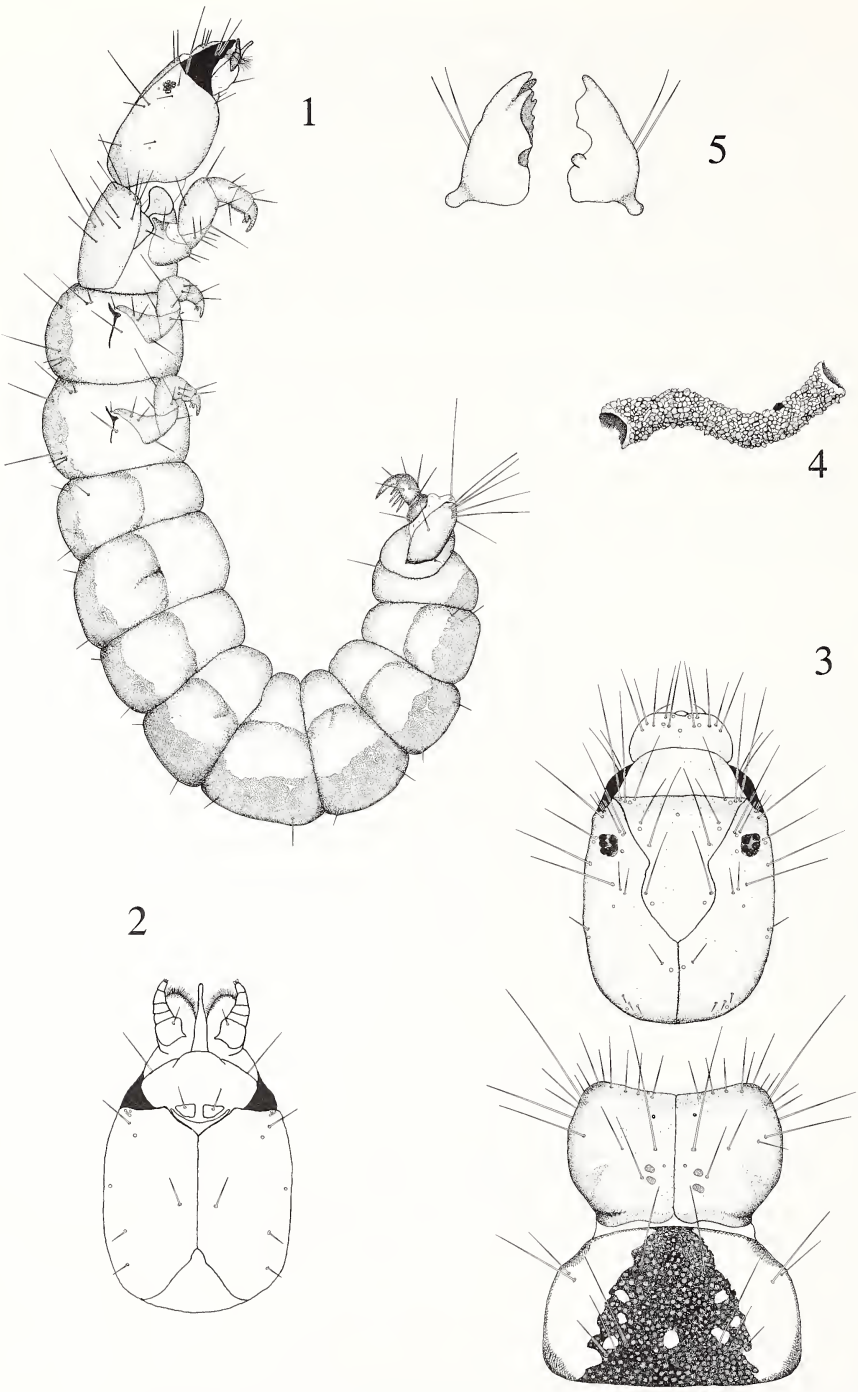
Abstract.—Larva and pupa of the genus *Paduniella* are described for the first time based on specimens of *Paduniella nearctica* Flint from the Ozark Mountains of Missouri and Arkansas, U.S.A. Larvae of *Paduniella* differ from *Tinodes* and *Lype* in having well developed teeth along the concave margin of the anal claw; they can be distinguished from larvae of *Psychomyia* by the submental sclerites being wider than long and small rather than longer than wide and large. The pupa of *Paduniella* is unique among Nearctic psychomyiids in having 6-segmented maxillary palpi, 4-segmented labial palpi, and 3 pairs of labral setae. Observations on the biology of the species suggest a scraper functional role for the larva and a bivoltine life cycle.

Adults of the genus *Paduniella* are unusual among the Trichoptera in having 6-segmented maxillary palpi and 4-segmented labial palpi. First erected by Ulmer (1913), the genus currently includes 25 species. Twenty-four of these are distributed in the Palaearctic, Oriental, and Afrotropical biogeographical regions. Only one species, *P. nearctica* Flint, is known from the Nearctic region where it is restricted to the Ozark Mountains of Arkansas and Missouri, U.S.A. (Flint, 1967; Bowles and Mathis, 1989; Mathis and Bowles, 1992). Current knowledge of the genus is limited to morphology of adult males and females of a few species. Nothing is known with regard to immature stages or their biology. Herein we describe the larva and pupa for the genus based on specimens of *P. nearctica* and offer some observations on the biology of this species. Setal nomenclature follows that of Williams and Wiggins (1981).

Paduniella nearctica Flint, 1967

Paduniella nearctica Flint, 1967, p. 311, figs. 1–4.

Larva (Figs. 1–5). Length of heat-killed, straightened larvae 5.7–7.2 mm, $\bar{x}$ 6.4 mm (N = 17); head capsule width 0.46–0.58 mm, $\bar{x}$ 0.52 mm (N = 191). Sclerites of head and pronotum light brown, without conspicuous patterns; mesothorax, metathorax, and abdomen white, yellow, or green with broad dark line running longitudinally along dorsum. Head capsule (Figs. 1–3) with 18 pairs of tactile setae, 5 pairs of proprioceptic setae, and 1 unpaired and 17 paired pit setae; pit seta 11 (P11) absent; antennae lacking prominent sensilla, each with 3 short, stout setae. Ventral apotome small, V-shaped, arms extended. Labrum fully sclerotized, with 6 pairs of tactile setae and 1 unpaired and 2 pairs of setal pits. Mandibles (Fig. 5) slender, each bearing 2 setae near midlength on lateral surface; left mandible with 2 large teeth dorsally



Figs. 1–5. *Paduniella nearctica,* terminal instar larvae. 1. Larva, lateral view. 2. Head, ventral view. 3. Head and thorax, dorsal view. 4. Larval tube. 5. Mandibles, dorsal view.

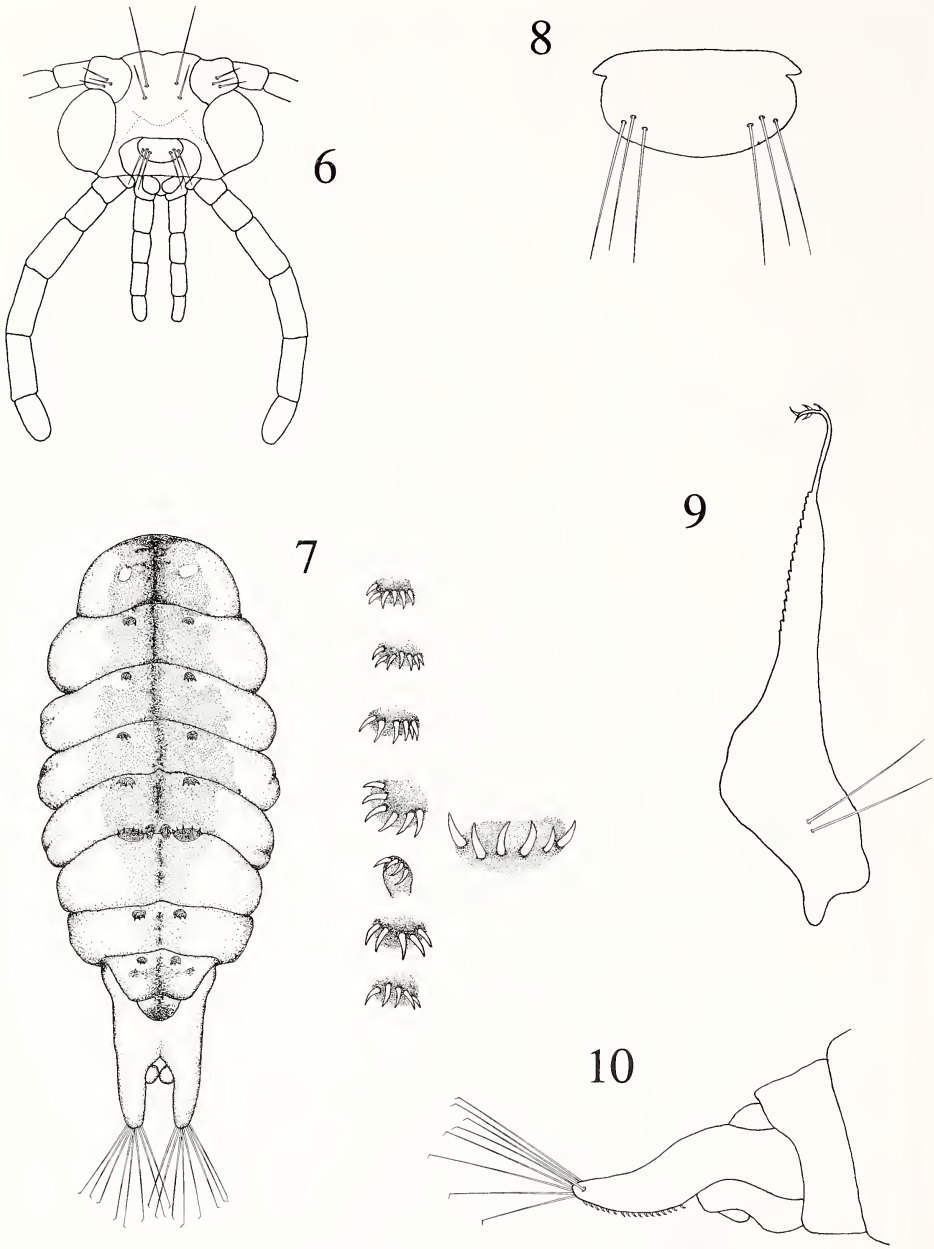
and numerous smaller teeth along ventral cutting edge; right mandible with prominent tooth apically, distinct notch located near midlength of mesal face. Maxillae each lacking well defined cardo and stipes, bearing single prominent seta laterally; palpifer present, bearing 1 seta; palpi 4-segmented, third segment longest; galea rounded, bearing numerous small hair-like setae, 2–4 tactile setae, and 4 or 5 sensilla. Labium bulbous basally, forming long narrow tube anteriorly that extends beyond the head, palpi absent; submental sclerites small, triangular, bearing 1 seta each.

Pronotum (Fig. 3) sclerotized, each half with 12–17 tactile setae, 3 pit setae, and 3 proprioceptic setae; anteromesal proprioceptor (seta 13) absent. Prosternum with 4 pairs of proprioceptic setae. Propleuron bearing two tactile setae; trochantin broad, flat, with 2 proprioceptic setae. Meso- and metanota each with 6 pairs of tactile setae (1 at *sa1,* 3 at *sa2,* and 2 at *sa3*), 1 pair of setal pits, and 3 pairs of proprioceptic setae. Meso- and metasterna each with 3 pairs of proprioceptic setae. Meso- and metapleura each a narrow sclerotized band; with two tactile setae and 2 proprioceptors in adjacent areas. Thoracic legs with primary setae only; prothoracic legs longer and stouter than those of other segments, bearing dense brush along mesal margin of tarsus; tarsal claws of all legs bearing 2 stout setae.

Abdomen dorsoventrally flattened, gills and lateral fringe absent; 5 anal papillae present, palmately arranged when extended; abdominal segment I distinctly shorter than other anterior segments. Segments I–VIII each bearing 5 pairs of tactile setae dorsally, 2 pairs laterally, and 3 pairs ventrally; segment IX lacking lateral setae; 2 pairs of dorsal and 1 pair of ventral proprioceptors present on most segments (segment I lacking ventral proprioceptor, segment IX lacking dorsal proprioceptors); setal pit 2 (P2) absent on all segments. Basal segment of each anal proleg bulbous, shorter than distal segment, bearing single small seta; lateral sclerite with 8 tactile setae, one seta on lateral surface, group of 6 long setae at posterior end, and smaller seta just anterior to this basal tuft. Anal claw with 4 stout teeth along ventral concave margin, fourth tooth one-half length of more anterior three; with 9 tactile setae and 2 prominent setal pits.

Larval tube (Fig. 4) constructed of sand grains and debris in depressions on surfaces of larger rocks; expanded slightly at ends; up to 22 mm in length and 2 to 3 mm wide.

Pupa (Figs. 6–10). Length 3.1–4.4 mm (N = 10). Head (Fig. 6) with 2 pairs of setae on frons; antennae each 24-segmented, scape with 3 short setae, other segments glabrous. Maxillary palpi each 6-segmented; labial palpi 4-segmented. Labrum (Fig. 8) with 3 pairs of setae located in 2 groups at anterolateral corners, setae without hooked apices. Genae each with two groups of 3 setae located near articulation points with mandibles. Mandibles (Fig. 9) long, slender; each tapering to short, narrow filament bearing 4 hooks near apex; with 2 setae near base and distinctly serrate cutting edge. Abdomen (Fig. 7) lacking gills and lateral fringe; base color white with black coloration dorsally, most intense near midline; abdominal hook plates with 4–10 well-developed hooks, located anteriorly on segments II–VIII and posteriorly on segment V; segment V with a dense bed of posteriorly directed spines just anterior to posterior hook plate. Anal processes (Figs. 7, 10) long; each divided into a small rounded, mesal lobe and long tubular lateral lobe; lateral lobe with a row of anteriorly directed spinules on venter and 8 apical setae with hooked apices. Pupal case constructed of sand grains and debris; smaller than larval tube, 7–9 mm × 3–3.5 mm; capped on both ends by a silken sieve plate.



Figs. 6–10. *Paduniella nearctica,* pupa. 6. Head, facial view. 7. Abdomen with sclerotized hook plates enlarged, dorsal view. 8. Labrum, dorsal view. 9. Mandible, dorsal view. 10. Anal process, lateral view.

Specimens examined. Arkansas, Washington County, Cove Creek, 12 mi south of Prairie Grove, 16 Apr. 1989, 2 larvae, Mathis; as above, 30 May 1989, 2 larvae; as above, 25 June 1989, 1 larva, 1 pupa; as above, 23 July 1989, 12 larvae; as above, 30 July, 29 larvae; as above, 5 Aug. 1989, 22 larvae; as above, 12 Aug. 1989, 20 larvae, 7 pupae; as above, 20 Aug. 1989, 31 larvae, 32 pupae; as above, 16 Sept. 1989, 20 larvae; as above, 25 Oct. 1989, 9 larvae; as above, 3 Jan. 1990, 57 larvae. Stone County, North Sylamore Creek, at Barkshed Recreation Area, 12 Mar. 1991, 6 larvae, Moulton and Abbott.

Diagnosis. The larva of *Paduniella nearctica* exhibits characteristics consistent with those of other members of the family Psychomyiidae; the prothoracic trochantin is broad and flat, the labium is extended beyond the anterior margin of the head, labial palpi are absent, and the prothoracic legs are stouter than those of other segments. Larvae of *P. nearctica* can be distinguished from those of other Nearctic psychomyiid genera based on two characteristics. The well-developed teeth on the concave margin of the anal claw distinguish *Paduniella* from larvae of *Tinodes* and *Lype* in which teeth are lacking (Wiggins, 1977). The submental sclerites of *P. nearctica* differ from those of *Psychomyia* being small and wider than long rather than large and longer than wide (Wiggins, 1977). The pupa of *P. nearctica* has 6-segmented maxillary and 4-segmented labial palpi which allows for easy separation from all other psychomyiids. The pupa is unique also in having only 3 pairs of labral setae rather than 5 pairs as is reported for pupae of the other Nearctic genera (Lepneva, 1964).

Habitat and biology. During the course of surveys for Trichoptera of the Interior Highlands, we have collected adults of *P. nearctica* from a number of headwater streams throughout the Ozarks of Arkansas and Missouri (Bowles and Mathis, 1989; Mathis and Bowles, 1992). These streams are among the least impacted in the region suggesting that the species may be intolerant to anthropogenic pollution and disturbances. At the type locality where we collected most of the specimens for the present investigation, the larvae of *P. nearctica* inhabited areas with low velocities and large stable substrates. Their tubes were constructed on the upper surfaces and sides of rocks typically within cracks and depressions. Analysis of gut contents revealed that larvae fed almost exclusively on diatoms during the winter (88% of food based on particle size), but, during the summer, detritus also was important (73% diatoms and 17% detritus). These food habits suggest a scraper functional role for the species (Merritt and Cummins, 1984). The shape of the larval mandibles having a well-developed cutting edge also suggests a scraper functional role for *P. nearctica.*

Although exhaustive sampling was not performed, some observations of the life history of *P. nearctica* were collected. Larvae overwintered as terminal instars, initiating pupation during late May to early June. A second period of pupation occurred in early to mid August suggesting that the species may be bivoltine. Adults have been collected from mid May until mid September (Bowles and Allen, 1988; Bowles and Mathis, 1989; Mathis and Bowles, 1992), but peak abundances occur at times corresponding to these periods of pupation. The biology and life history of the species were the subject of a recent investigation from which results should be available shortly (S. Williams, pers. comm., 1993).

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